The Value of Renewable Energy as a Hedge Against Fuel Price Risk

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Introduction

New natural gas power plants have represented over 95% of all electric generation capacity additions in the United States over the last several years, and power sector demand for natural gas is expected to continue on an upward trend. However, recent volatility in wholesale electricity prices, driven in part by natural gas price variability, highlights the risk of relying too heavily on gas-fired generation. Concerns about the price and supply of natural gas have grown in recent years, and futures and options markets predict high prices and significant price volatility to continue for the foreseeable future. Clearly, the variability and uncertainty of gas prices poses a major risk to both buyers and sellers of gas-fired generation.

Against this backdrop, renewable energy (RE) – which by its nature is immune to natural gas price risk – can provide a real economic benefit. While the benefits of RE as a price risk mitigation tool have been recognized for years, quantification of these values has lagged. The principal purpose of this paper is to highlight recent analytic work that has begun to quantify the value that RE provides as a hedge against natural gas price risk. RE can mitigate this risk in two ways: (1) by providing electricity purchasers with a long-term fixed-price source of supply, and (2) by placing downward pressure on natural gas prices. This paper discusses both of these potential benefits.

The Benefits of Fixed-Price Renewable Energy Supply[2]

Unlike many contracts for gas-fired generation, which are indexed to the highly variable spot price of natural gas, renewable generation is typically sold under long-term *fixed-price* contracts.[3] An obvious question that therefore arises is how to appropriately compare the levelized cost of fixed-price RE to the levelized cost of variable-price gas-fired generation. The current practice, common in analytic studies and utility planning, is to compare the levelized cost of these two resources based on an inherently *uncertain* – and notoriously *inaccurate* – fuel price forecast. Figure 1, which compares nearly twenty years of Energy Information Administration (EIA) natural gas price forecasts to realized prices in the market, shows that the past accuracy of natural gas price forecasts leaves much to be desired. Arguably, using such forecasts as a fuel price input to levelized cost comparisons between gas-fired and renewable

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[2] This section is based on Bolinger, M., R. Wiser and W. Golove. 2003. “Accounting for Fuel Price Risk: Using Forward Natural Gas Prices Instead of Gas Price Forecasts to Compare Renewable to Natural Gas-Fired Generation.” LBNL-53587. Berkeley, Calif.: Lawrence Berkeley National Laboratory.
[3] It deserves note that gas-fired generators can also offer fixed-price electricity contracts *if* their fuel price is hedged through futures, forwards, or swap contracts. Such contracts, however, may not be available for the terms typical of RE contracts (10-30 years), and furthermore will incorporate any costs incurred to consummate the fuel price hedge.

generation results in an "apples-to-oranges" comparison, because it does not account for the relative certainty of the cost of RE compared to the uncertain cost of gas-fired generation.

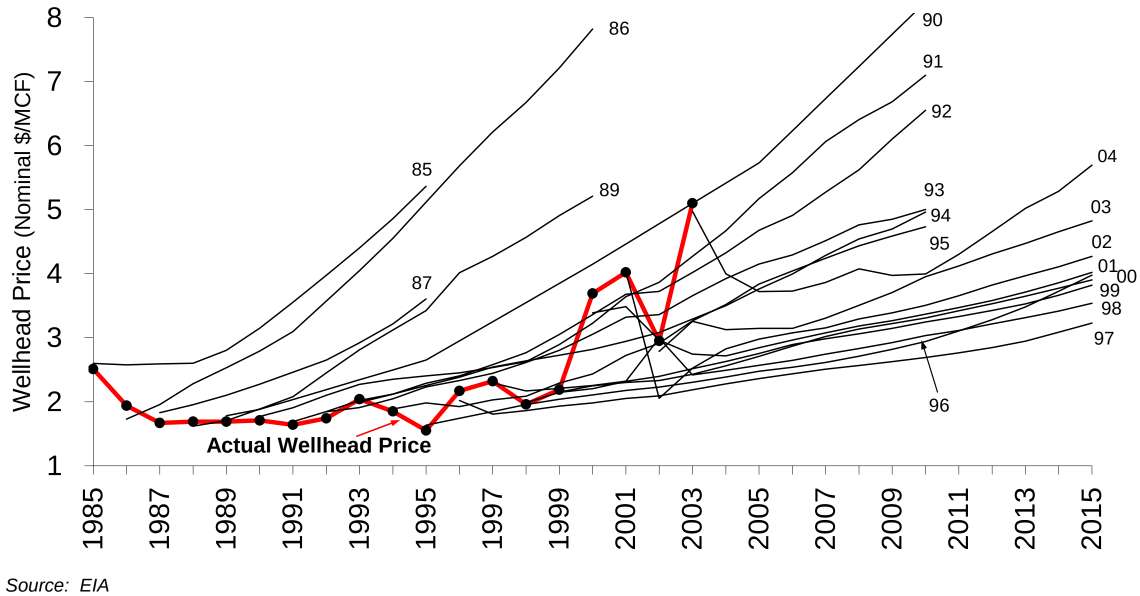

Figure 1. Historical AEO Wellhead Gas Price Forecasts vs. Actual Wellhead Price

A more appropriate approach might be to compare the levelized cost of RE to the levelized cost of gas-fired generation based on a *guaranteed* price of natural gas that can be locked in with forward, futures, or swap contracts. This recommendation raises a critical question: how have the prices contained in uncertain long-term price forecasts compared to actual forward gas prices in recent years?

To answer this question, we have collected futures, forward and swap gas prices of up to ten years in duration that were priced in November 2000 – November 2003, and have compared these market prices to contemporaneous price forecasts generated by the EIA in its Annual Energy Outlook (AEO) series. Our findings are summarized in Figure 2, which shows that forward markets for natural gas have consistently traded at a substantial premium relative to the EIA AEO reference case price forecasts in recent years. Specifically, over terms of 2-10 years, the forward market has traded at a premium of ~$0.5-0.8/MMBtu, which translates into a 0.35-0.55¢/kWh premium at heat rate of 7,000 Btu/kWh.

While the limited data set restricts our ability to extrapolate these findings widely, we can safely conclude that to lock in gas prices for any appreciable period over the last 4 years, one has had to pay a premium relative to EIA reference case forecasts of approximately $0.5-0.8/MMBtu. Moreover, this finding is not restricted to the EIA reference case gas price forecasts: private sector gas price forecasts over the same period have also generally been lower than our forward price sample, and in many instances lower than the EIA reference case forecasts, resulting in an even greater "wedge" between forwards and forecasts than reflected in Figure 2.

As such, the use of gas price forecasts over this time period may have "biased" investment decisions towards variable-price gas-fired generation, and away from fixed-price RE. While it is unclear whether forward markets for natural gas will continue to trade at a premium to gas price forecasts (and some debate surrounds the explanation for the observed premiums of the last several years), this does not change the fundamental implications of this work: *one should not blindly rely on gas price forecasts when comparing fixed-price renewable with variable-price gas-fired generation contracts and, when possible, one should use forward prices (not price forecasts) in making such comparisons.*

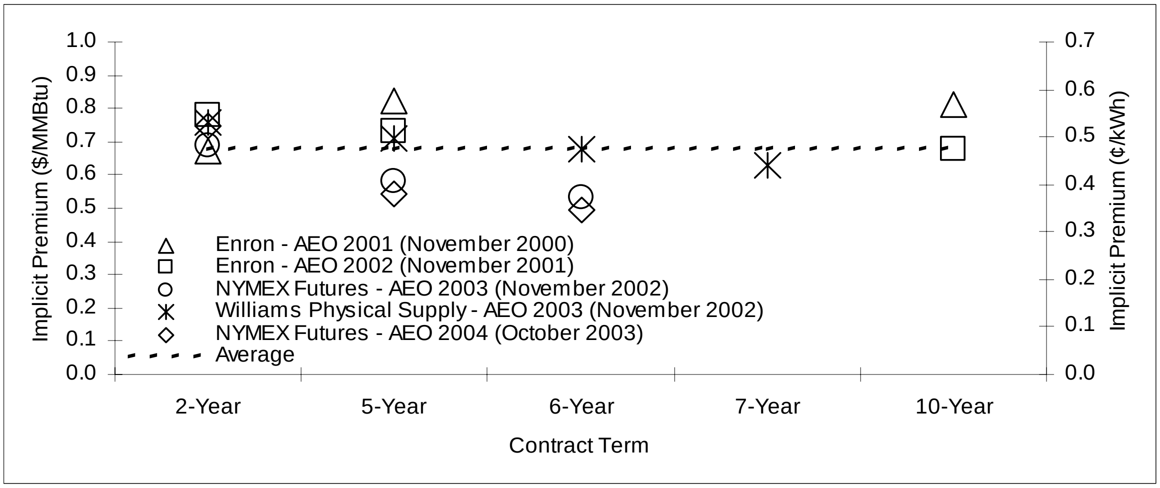

Figure 2. Implied Premiums in $/MMBtu and ¢/kWh (assuming 7,000 Btu/kWh)

The Impact of Renewable Energy Deployment on Natural Gas Prices[4]

In addition to directly hedging gas price risk, RE displaces marginal gas-fired generation, thereby reducing demand for natural gas and placing downward pressure on gas prices. An ongoing study by Berkeley Lab reviews the reasonableness of this effect as portrayed by the modeling output of various studies, and benchmarks that output against economic theory, with the ultimate goal of better understanding how sizable this impact might be.

A review of the economics literature shows that this effect is to be expected, because increased use of RE can shift the demand curve for gas inward, and assuming an upward sloping supply curve, result in a lower equilibrium price. The magnitude of the price reduction will depend on the relationship between the level of natural gas production and the price of supply, which itself can be measured with the inverse price elasticity of supply. Due to the respective shapes of long- and short-term natural gas supply curves, the price reduction is expected to be less significant in the long term than in the short term.[5]

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[4] This section is based on Wiser, R., M. Bolinger and M. St. Clair. 2004. “Putting Downward Pressure on Natural Gas Prices: The Impact of Renewable Energy and Energy Efficiency.” ACEEE Summer Study on Energy Efficiency in Buildings. Pacific Grove, Calif.: American Council for an Energy-Efficient Economy.

[5] Importantly, the direct impact of this natural gas price reduction does not represent an increase in aggregate economic wealth per se, but is more accurately understood as a benefit to consumers that comes at the expense of natural gas producers. Conventional economics does not support government intervention on these grounds. If policymakers, however, are uniquely concerned about the impact of gas prices on consumers, or the resulting

A large number of recent studies, many of which use the EIA's National Energy Modeling System (NEMS) to analyze the impacts of a federal renewables portfolio standard (RPS), include an evaluation of this effect. These studies – which primarily focus on longer-term price impacts – demonstrate that this effect on natural gas prices could be significant. In particular, the twelve studies that we have evaluated (authored by EIA, UCS, Tellus, and ACEEE) find that increased RE (along with energy efficiency, EE, in a subset of the studies) has the potential to offset significant amounts of gas demand in the USA (0.4% to 30% could be offset by 2020), and thereby suppress gas prices (0% to 50% reduction in wellhead gas prices by 2020). The more significant reductions in gas consumption and prices are associated with studies that evaluate aggressive RE/EE deployment.

Wellhead gas price reductions translate into reduced bills for natural gas consumers, and also moderate electricity prices by reducing the price of gas delivered to electricity generators. Because renewable generation is sometimes more costly than conventional generation, however, the net predicted effect on consumer energy bills can be positive or negative. Taking a subset of the studies that analyze the potential impacts of a national RPS, Figure 3 presents the predicted effects of a national RPS on consumer natural gas and electricity bills. As shown, even for those studies that predict increased consumer electricity bills, the net present value of this increase is often expected to be largely, if not completely, offset by the net present value of the cumulative predicted decrease in natural gas bills. From an aggregate *consumer* energy bill impact perspective, therefore, the net impact of these policies is typically expected to be rather small, or even positive in many instances.

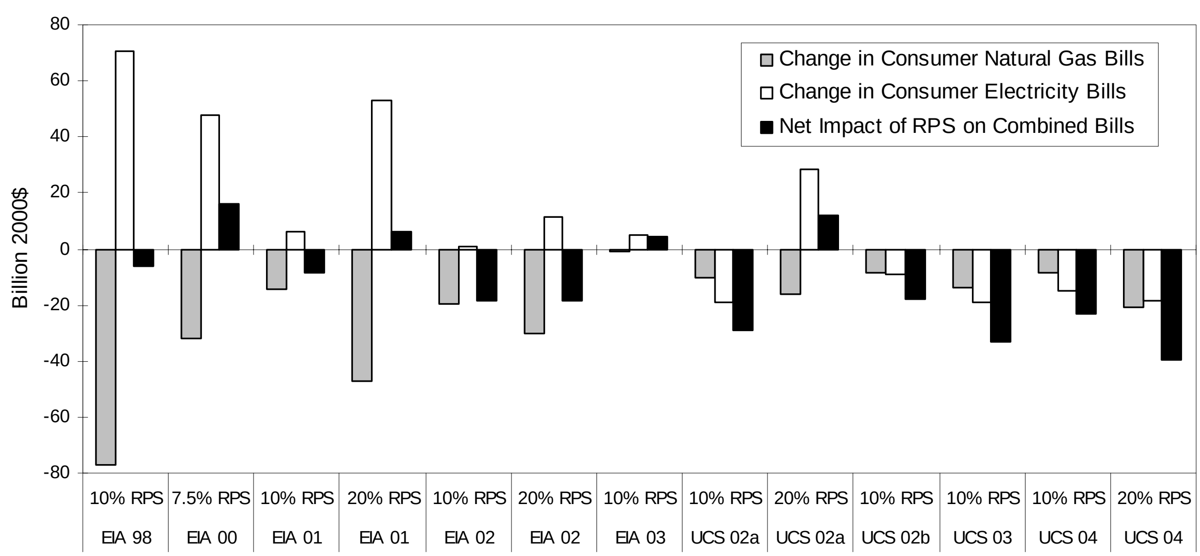

Figure 3. Net Present Value of RPS Impacts on Electricity and Natural Gas Bills (2003-2020, 5% Real Discount Rate)

To test for model consistency, one can compare the natural gas price response to increased RE and EE deployment across studies by calculating the inverse price elasticity of supply implied by

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economic dislocation that might occur, then policies to reduce gas demand might be considered appropriate on wealth redistribution grounds.

the results of each study. Doing so requires data on the predicted average wellhead price and total gas consumption in the USA, under both the business-as-usual scenario as well as the policy scenario of increased RE/EE deployment. The results of these calculations show that the twelve studies that we have reviewed present a consistent story: reducing the demand for natural gas is expected to lead to lower gas prices. While the magnitude of the long-term inverse price elasticity varies substantially across models and years, the central tendency appears to be in the range of 0.75 to 2.5: a 1% reduction in national gas demand is expected to cause a corresponding long-term wellhead price reduction of 0.75% to 2.5%, with some studies predicting even more sizable reductions. After benchmarking these results against other NEMS modeling output, other national energy models, and a limited empirical literature, we conclude that many of the studies of the impact of RE on natural gas prices appear to have represented this effect within reason, given current knowledge.

That said, there are sometimes significant changes in the implicit inverse elasticities not only across models, but also between years within the same modeling run and between modeling runs using the same basic model. Inverse elasticities do not always remain within reasonable bounds. Combine this with the fact that the natural gas supply curve is unknown, and that the historic ability of energy modelers to predict future gas prices is dismal, and it is clear that more effort needs to be placed on accurately estimating the supply curve for gas and in validating modeling treatment of that curve, before any single modeling result can reasonably be relied upon.

In the mean time, it is more appropriate to consider a range of natural gas elasticity estimates when estimating the long-term impact of RE on natural gas prices. Based on our review of the available evidence, inverse elasticities of 0.75 – 2.5, or even higher, appear to be reasonable. Elasticities in this range further suggest that any expected increase in consumer electricity costs that are caused by increased RE penetration will be substantially offset by an expected reduction in delivered natural gas prices.

Conclusions

Renewable energy has historically been supported through a myriad of public policies, typically justified by the environmental, economic development, fuel diversity, and security benefits that increased RE might provide. Among these benefits, the value of RE as a hedge against natural gas price volatility and escalation has received considerable recent attention.

Results presented in this paper suggest that resource diversification with RE has the potential to alleviate the threat of high and volatile natural gas prices. We demonstrate that RE provides two distinct benefits as a price hedge. First, in contrast to gas-fired generation, long-term contracts for RE are typically offered on a fixed-price basis, and the purchase of RE can thereby directly mitigate fuel price risk. Second, an increasing number of studies show that aggressive levels of RE penetration may put downward pressure on natural gas prices by reducing demand and thereby easing supply pressures. This paper demonstrates that both benefits may be significant, but that additional research will be necessary to fully understand and value these potential advantages.